

**Request for Class 2 Permit Modification in Accordance
with WIPP Permit Condition I.B.1**

**Waste Isolation Pilot Plant
Carlsbad, New Mexico**

Notice of Class 2 Permit Modification in Accordance with WIPP Permit Condition I.B.1

Consistent with the requirements of 20.4.1.900 New Mexico Administrative Code (NMAC) (hereafter referred to as Part 270 or Section 270.XX) the U.S. Department of Energy, Carlsbad Field Office is submitting to the New Mexico Environment Department (NMED) a request for a Class 2 modification to the Hazardous Waste Facility Permit (NM4890139088-TSDF) for the Waste Isolation Pilot Plant (WIPP). Specifically, this information is provided to comply with the requirements of the HWFP condition I.B.1.

The requested modification is listed in Attachment A. Listed information includes references to the applicable sections of the Permit, the title of the item and the relevant permit modification category as identified in 20.4.1.900 NMAC. A more complete description of the Class 2 modification is provided in Attachment A.

The changes requested by this modification do not reduce the capacity of the facility to protect human health or the environment.

Table 1. Class 2 Hazardous Waste Facility Permit Modifications

No.	Affected Permit Section	Item	Category (40 CFR 270.42, App. I)	Attachment A Page #
1	a.1. Module II b.1. Attach. B-1c b.2. Attach. B-3c b.3. Attach. B-3d(2) b.4. Attach. B-4a(1) b.5. Table B-6 b.6. Figure B-3 b.7. Table B-7 c.1. Attach. B1 c.2. Attach. B1-3a c.3. Attach. B1-3b(2) c.4. Attach. B1-3b(3) c.5. Attach. B1-3b(5) d.1. Attach. B2 d.2. Attach. B2 d.3. Attach. B2-1 d.4. Table B2-1 d.5. Equation B2-3 e.1. Attach. B3-1 e.2. Attach. B3-4 e.3. Attach. B3-9 e.4. Attach. B3-10a(1) e.5. Attach. B3-10a(2) e.6. Attach. B3-10b(1) e.7. Attach. B3-11 e.8. Attach. B3-12b(1) e.9. Table B3-11 f.1. Attach. B4-1 f.2. Attach. B4-3d g.1. Attach. B6 g.2. Table B6-1 g.3. Table B6-2 g.4. Table B6-3 g.5. Table B6-4 g.6. Table B6-6 g.7. Table B6-7 g.8. Table B6-8 g.9. Table B6-9 g.10. Table B6-10	Alternate Method For QC of Radiography	B.2.b	A-1

Attachment A

**Description of the Hazardous Waste Facility Class 2 Permit Modification
Request**

Item 1

Description:

This modification represents a change to the quality assurance/control plan of the Hazardous Waste Facility Permit (HWFP). The classification for such changes are indicated in 40 CFR §270.42, Appendix I. Section B.2.b of that appendix indicates that “other” changes to the quality assurance/control plan are classified as Class 2 modifications. Therefore this modification is submitted as a Class 2 change.

The HWFP currently requires that a statistically selected portion of the certified waste containers be opened and visually examined as a Quality Control (QC) check on radiography. This confirmation by visual examination (VE) determines both (1) the physical form of the waste and (2) the absence of prohibited items. Recent improvements in technology now make it possible to perform these confirmations without opening the containers, using high-resolution digital radiography and computed tomography (DR/CT) in place of more invasive techniques. Using DR/CT in place of VE will eliminate the potential for accidental radiation exposure or releases and preclude the generation of additional TRU mixed waste. This use of DR/CT in place of VE is fully consistent with the requirements and objectives of the HWFP, federal and state law.

This modification revises requirements for QC checks when using digital radiography and computed tomography (DR/CT) as a confirmation technique. This modification allows independent interpretations of DR/CT scans as an alternative to visual examination (VE) as a QC check of radiography.

Basis:

Radiography is a technique in the Hazardous Waste Facility Permit (HWFP) to verify acceptable knowledge (AK) used to characterize transuranic (TRU) mixed waste. DR/CT is an approved form of radiography and can currently be used to characterize TRU and TRU mixed wastes. DR/CT is a sophisticated and powerful tool which is unique in its ability to be used as a QC check on radiography. A description of the technical specification and typical system operations is included as Attachment B.

DR/CT uses a linear diode array (solid-state x-ray detector) with a conventional or LINAC-based x-ray generator to meet the radiography requirements in the HWFP (Section B1-3a). In addition, the DR/CT system uses computed tomography to supply circular cross-sectional images of a drum's contents as a non-invasive method to meet the VE requirements of the HWFP.

Within the HWFP, VE operators confirm radiography by, among other things, confirming the physical form of the waste and the absence of prohibited items. VE is one of seven QC measures for radiography to ensure data quality objectives are met. QC is defined by the U.S. Environmental Protection Agency (USEPA) in SW-846, Chapter 1, Section 2.5 as the process by which the

precision and bias in data collection activities are kept within acceptable bounds.

The HWFP requires four direct measures and three indirect measures to ensure adequate QC of radiography. The direct measures are:

1. Formal training (Section B1-3b),
2. On-the-job training (Section B1-3b),
3. Independent replicate scans (Section B1-3b), and
4. Visual examination (Section B1-3b).

The indirect measures are:

5. Independent observation of scans (Section B1-3b(2)),
6. Permittee review of 1% of the radiography tapes for containers sent to WIPP (Section B-1c), and
7. Data review, verification and validation at both the data generation and project levels for all radiography data (Section B3-10).

Each is described below:

Measures 1 and 2: The permit states in Section B1-3b that: “Operator training and experience are the **most important considerations** for assuring quality controls in regard to the operation of the radiography system and for interpretation and disposition of radiography results” (emphasis added). To ensure that adequate training occurs, the HWFP provides criteria for formal and on-the-job training content, methods, and requalification. This permit modification only proposes an alternative to using VE for QC on radiography when DR/CT is used with no changes to the training requirements established by the HWFP. No changes have been proposed to the industry standard training requirements and/or qualifications as stipulated in the HWFP (Section B1-3b(1), B1-3b(2)).

Measures 3 and 5: Section B1-3b(2) requires that an independent replicate scan and an independent observation be performed at the rate of one waste container per day or one per testing batch, whichever is less frequent. This Permit modification uses independent reviews of a DR/CT scan as a direct measure of radiography data quality.

Measure 4: In addition to the independent replicate scans, Section B1-3b(3) requires another QC check on radiography, which is the visual examination of a statistically determined number of containers to verify the radiography results. The HWFP states, regarding visual examination, that the verification of the radiography: “...shall include the Waste Matrix Code and waste material parameter weights...”. Further, the HWFP states that: “Visual examination shall be conducted to describe all contents of a waste container, and includes estimated or measured weights of the contents. The description shall clearly identify all discernible waste items, residual materials, packaging materials, or waste material parameters.”

Based on technological advancements to radiography (i.e., DR/CT), the requirements for performing QC of radiography can be met without VE when using DR/CT. This permit modification proposes using independent interpretations of the DR/CT scan data collected for the container as a QC check in lieu of using VE as a QC check.

Measures 6 and 7: These indirect measures are unchanged by this modification.

Discussion:

In the process of meeting the waste characterization and waste confirmation requirements of the WIPP HWFP, the DOE must balance the requirements to provide accurate and complete data and the requirements to minimize radiation exposure and the potential for releases that could expose workers, the public, or contaminate facilities. Both the hazardous waste characterization requirements and the radiation protection requirements have their basis in federal and state statutes and are codified in established regulations. 42 U.S.C. 6905, Section 1006(a) states that, "Nothing in this chapter shall be construed to apply to (or to authorize any state, interstate, or local authority) to regulate any activity or substance which is subject to the...Atomic Energy Act...except to the extent that such application or regulation is not inconsistent with the requirements of such Acts." The method proposed is consistent with both the Atomic Energy Act and the RCRA. To this end, the permit requires and the DOE use both non-invasive and invasive techniques to examine the contents of containers of TRU mixed waste to meet the characterization and confirmation obligations of the HWFP.

Non-invasive techniques are preferable because they minimize the possibility that a worker will inhale, ingest or become contaminated with TRU radionuclides. Specifically, radiography does not require that containers be opened, thereby minimizing risk. Invasive techniques have inherently greater potential exposure risks than those associated with non-invasive techniques. Three invasive techniques are mandated in the HWFP: headspace gas sampling, solids sampling, and visual examination. DOE has developed headspace gas sampling techniques that allow a sample to be obtained without opening the container—thereby reducing exposure risk. Solids sampling and visual examination, however, remain two mandated techniques that require opening containers and performing activities in direct contact with the waste.

The DOE has a dual mandate to satisfy HWFP conditions and reduce exposure and radiation risk. Therefore, the DOE is seeking technological improvements that will minimize the risks associated with invasive characterization techniques and, at the same time, meet the goals of the HWFP. This requested permit modification is part of this mandate with regard to the visual examination of waste.

The DOE's request is to use an independent review of the results of radiography using DR/CT in place of an invasive technique (i.e., VE) as a QC check on radiography. This change alone will significantly eliminate the potential for

accidental radiation exposure or releases and preclude the generation of some additional TRU mixed waste. It is supported by hazardous waste regulatory guidance and ALARA. The requested modification for DR/CT supports meeting the Quality Assurance Objectives (QAOs) for quality control of radiography required by the HWFP. These QAO's ensure that the radiography data can be used confidently.

The subsequent paragraphs discuss the following:

- Specification of VE-related QAOs for the independent review of the DR/CT data
- The use and frequency of independent interpretation of the DR/CT scan to collect information needed to meet the VE-related requirements for assuring radiography data quality
- The Performance Evaluation Program for DR/CT which provides for opening (non-radioactive) test containers as a visual check on DR/CT performance
- The direct comparison of DR/CT data to VE for meeting VE-related permit requirements
- The requested implementation process for an independent interpretation of DR/CT data as an alternative to performing VE on TRU waste containers

Subsequent paragraphs also describe the technology as well as the benefits that accrue to the hazardous waste program and the DOE radiation protection program from using an independent interpretation of DR/CT data in lieu of VE.

Quality Assurance Objectives Applicable to the Independent Review of DR/CT Data

Section B3 of the HWFP provides the QAOs for waste characterization activities, including radiography. The precision and accuracy QAO's rely on the results of VE. This is explained as follows:

Section B3-4 of the HWFP establishes the following relative to the use of VE data to determine the quality of radiography:

- A Precision QAO for radiography requiring that:
"As a measure of precision, the Permittees shall require each Site Project QA Officer to calculate and report the RPD between the estimated waste material parameter weights as determined by radiography and these same parameters as determined by visual examination. Additionally, the precision of radiography is verified prior to use by tuning precisely enough to demonstrate compliance with QAOs through viewing an image test pattern."
- An Accuracy QAO for radiography stating:
"The programmatic accuracy at which the waste matrix code and waste material

parameter weights can be determined must be documented through visual examination of a randomly selected statistical portion of waste containers. The Permittees shall require the Site Project QA Officer to calculate and report the miscertification rate of waste containers that require assignment to a different waste matrix code or are found to contain prohibited items after visual examination as a measure of radiography accuracy. The miscertification rate shall be used to determine the number of drums subject to confirmatory visual examination.”

The miscertification rate is defined in Attachment B2 of the HWFP and is based on how often radiography did not detect a prohibited item that was in the container and how often the waste was incorrectly identified based on the waste form.

Both the precision and accuracy QAOs use an independent observation of the container contents as a measure of the data quality. Currently this independent observation must be VE. The results of the VE are used to ensure the radiography data quality by calculating the material parameter weight, relative percent differences (RPDs) and the miscertification rate.

The requested modification does not make any changes to the calculations that are used to establish the material parameter weight, RPDs or the miscertification rate. However, the data used for satisfying these QAOs come from independent reviews of DR/CT scans instead of VE. This process and frequency are described below.

Use of Independent Interpretation of DR/CT Scans

To further ensure the QC of radiography, the HWFP establishes two other requirements for conducting radiography. Section B1-3b(2) requires that an independent replicate scan and an independent observation be conducted once per day or once per testing batch, whichever is less frequent. The separation of the independent replicate scan and the replicate observation is related to the way that non-digital radiography works with video cameras. The replicate scan is necessary because an independent radiography operator cannot investigate the container contents at different magnifications or perspectives using only the videotape record. Therefore, a fully independent evaluation of the drum contents cannot be made without physically re-scanning the container. DR/CT, however, provides a digital record that allows the second operator to conduct a fully independent evaluation of the container contents without re-scanning the container. This is accomplished by using software that provides a three-dimensional image of the container that can be rotated and magnified by the second operator independent of how it was done by the original operator. Therefore, when the DR/CT technology is used the independent replicate scan and an independent observation requirements are equivalent and are met using independent review and interpretation of the digital record from at least two randomly selected containers per batch or two per day, whichever is less frequent.

The modification proposes that when DR/CT is used, the results of the independent review of the DR/CT scans may be used in lieu of VE results for the purpose of meeting the radiography QAOs of precision and accuracy. Because of the dynamic range of the DR/CT and the ability to examine the container contents layer by layer digitally, the DR/CT operator is able to prepare an inventory of waste items, residual materials, and packaging materials to use in estimating material parameter weights. The modification requires that, if the independent DR/CT scans are used in lieu of VE, the material parameter weight RPDs required by the precision QAO and the misclassification rate required by the accuracy QAO be calculated using the independent DR/CT results.

Using the Performance Evaluation Program to Assure DR/CT Quality

The requested modification incorporates a Performance Evaluation Program to provide QC of radiography for sites using DR/CT. The Performance Evaluation Program is a site-specific evaluation of radiography results that allows sites to use DR/CT to examine test drums and then perform VE on those drums as a measure of DR/CT accuracy. This program is based on the use of radiography test drums as indicated in Section B1-3b(2) of the HWFP. The program is defined as site-specific because the waste types, forms and configurations will vary among the various generator/storage sites and it is important that a site evaluate waste forms typical of what is expected. The Performance Evaluation Program will consist of at least two Performance Evaluation Program test drums per Summary Category Group that must be scanned on a quarterly basis. These drums must be evaluated by each qualified operator.

A Performance Evaluation Program drum shall include items common to the waste streams to be generated/stored at the generator/storage site. The Performance Evaluation Program drums shall be divided into layers with varying packing densities or different drums may be used to represent different situations that may occur during radiography examination at the site. Performance Evaluation Program drums representative of the applicable Summary Category Groups must be examined and the contents successfully identified.

The Performance Evaluation Program drums must be reconfigured each quarter (i.e., the contents varied) to ensure variability in the testing program. The test drums must contain 6 or more of the following items, singly or in multiples:

- Aerosol can with puncture
- C Horsetail bag
- C Pair of coveralls
- C Empty bottle
- C Irregular shaped pieces of wood
- C Empty one gallon paint can
- C Full container
- C Aerosol can with fluid
- C One gallon bottle with three tablespoons of fluid

- C One gallon bottle with one cup of fluid (upside down)
- C Leaded glove or leaded apron
- C Wrench

Performance Evaluation Program drums must be repackaged each quarter to assure variability.

As an analogy to VE a visual record of the contents of these drums must be created and compared to the DR/CT scan and interpretation. Failure to identify any of the objects that are present in a Performance Evaluation Program drum or to identify the physical waste form would be considered unsatisfactory performance and appropriate corrective action must be taken as addressed in HWFP Section B3-13.

Implementation of the Performance Evaluation Program at the generator/storage sites is the responsibility of the Site Project Manager (SPM). All necessary changes to the generator/storage site's Quality Assurance Project Plan (QAPjP) to implement the Performance Evaluation Program will be the responsibility of the SPM.

Direct Comparison of Independent Review of DR/CT Scan and VE in Meeting the Permit Requirements for Radiography QC

The HWFP has nine separate requirements that are to be met when performing QC of radiography. These requirements and corresponding sections of the HWFP are listed below:

- Physical Form--Sections B-3c, B-3d, and B1-3b(1) require that VE verify the physical form of the waste as determined by radiography.
- Prohibited Items--Prohibited items are residual liquids and containerized gases (e.g., unvented aerosol cans). Others are only identifiable through "indicators". The identification of prohibited items is required by Sections B-3c, B2-1, B3-12(b)(1) of the permit.
- RCRA Items--RCRA items are not directly identifiable. Radiography supports the confirmation of AK that may identify RCRA constituents. Section B-3d states:

"Radiography and/or VE, and the associated information compiled from acceptable knowledge (e.g., age of the waste, generating process) will be used to determine the RCRA-regulated constituents present in waste."

- Procedures--All sites are required by the permit to have standard operating procedures for each specific method employed. See for example Sections B1-3a and B1-3b(5)
- Material Parameter Weights--Sections B1-3a, B1-3b(3), B2-1 require the estimation or measurement of material parameter weights.

- Inventory of Items—Section B1-3a suggests that an inventory of waste items, residual materials and packaging materials be used to estimate material parameter weights. Section B1-3b(3) requires that all of the contents of the container be described.
- Dense Items—Section B1-3a addresses the need to perform VE for some dense items.
- Record—Section B1-3b(3) requires an audio/video record of VE activities.
- Opaque Items—Section B1-3b(3) stipulates that the VE expert assess the need to open individual bags or packages when the items are not discernible.

It should be noted that all the applicable HWFP requirements are met with the independent review of a DR/CT scan. Table 2 has been prepared to detail how the requirements for QC of radiography are met by an independent review of a DR/CT scan. Additional documentation that the DR/CT system performs as indicated is shown in Attachment B.

A demonstration of the capability of the DR/CT method was presented to the NMED in November 2000.

The conclusion from Table 2 is that the independent interpretation of the DR/CT scan meets the requirements for performing QC of radiography and therefore is a viable alternative for VE in this capacity.

Process for Implementing the Requested Modification

This modification implements a QC check on radiography by having an independent operator interpret the DR/CT scans. The rate of independent interpretation under the modification is 2 containers per batch or 2 containers per day, whichever is less frequent. These independent interpretations of the DR/CT scan are equivalent to the independent replicate scan and independent observation required by the HWFP for radiography and will provide the data needed to meet the precision and accuracy QAOs required by Section B3-4 of the HWFP.

The independent interpretations of the DR/CT scans would also be used to determine an appropriate miscertification rate as required by Permit Attachment B2-1. Regardless of the miscertification rate, the sampling rate would not be fewer than 2 per batch or 2 per day, whichever is less frequent.¹

¹To put this sampling rate into perspective, one need only consider the Rocky Flats Environmental Technology Site (RFETS), Hanford and Idaho National Engineering and Environmental Laboratory (INEEL) all of whom have identified no miscertifications since the inception of their program under the WIPP Permit. These sites have a zero percent (0%) miscertification rate. However, HWFP requires sites with less than 1% miscertification rate to default to the requirements for a 1% miscertification rate. The HWFP requires the use of Table

The radiography procedures will be as required within the HWFP (Section B1-3) except that for DR/CT systems, the container need not be re-scanned. The radiography operator/reviewer will be trained to the requirements of the HWFP (Section B1-3). The miscertification requirements will remain as specified in Section B2-1.

DR/CT Technology Evaluation

There have been technological advances in radiographic equipment for waste evaluation in recent years. These advances have increased the capability to accurately identify the physical form of the waste and to identify prohibited items without intrusive inspection. With technological advances such as high energy x-ray sources and/or highly sensitive detectors coupled with digital radiography and computed tomography even items such as high density waste, opaque containers, pipe overpacks, and lead lined drums can be easily viewed. The resolution and definition of these images are more representative of high definition television rather than the less defined x-ray images associated with radiography. The entire container can be viewed in 3 dimensions, and the container can be scanned in slices to allow even more in-depth analysis of particular portions of the waste that are of interest. Figures showing the definition of current radiological techniques can be viewed at the Internet addresses shown in Attachment B.

It is this high resolution capability coupled with the capability to examine the drum layer-by-layer digitally that enables DR/CT to provide more than sufficient information to satisfy the VE requirements.

To ensure the quality and consistency of radiography, any generator/storage site that chooses to employ the new technology for QC of radiography must use a high-energy x-ray source and/or highly sensitive detector coupled with digital radiography and computed tomography system.

The ability of DR/CT technology to allow the operator to accurately identify the

B2-1 to determine the specific number of containers to be sampled (i.e., the sampling rate) based on both the miscertification rate and a total number of containers in a Summary Category Group to be radiographed in a year. For example, with a 1% miscertification rate, if 200 containers are being processed in a year this results in 15 containers that must be independently evaluated. This is equivalent to a 7.5% sampling rate. As the annual number of containers that are radiographed goes up, the corresponding sampling rate goes down for a given miscertification rate (e.g., for a 1% miscertification rate 16 containers per 2000 must be subjected to independent verification. This is a sampling rate of 0.8%). Therefore, for all but the smallest number of radiographed containers (i.e., less than 200 per year) the proposed implementation of 2 per batch or 2 per day will likely provide more data for calculating the miscertification rate than is currently required by the hypergeometric sampling approach in the permit.

contents of waste containers was rigorously evaluated during the Rapid Commercialization Initiative (RCI). This program is a joint effort by Federal and State agencies and private enterprise to expedite the application of new environmental technologies. In August, 1998 the DR/CT technology was evaluated by the following agencies:

- U.S. Department of Energy Technology Center
- Idaho National Engineering and Environmental Laboratory
- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- The Southern States Energy Board
- The Western Governors Association
- California Environmental Protection Agency
- Colorado Department of Public Health and Environment
- Idaho Division of Environmental Quality
- South Carolina Department of Health and Environmental Control
- Washington Department of Ecology

A total of 5 DOE generated drums and 3 surrogate drums were independently characterized for use in this study. Using DR/CT the operator was able to verify all drum content codes (waste types) and matrices and successfully meet the verification objectives of this RCI project.

TABLE 2
DESCRIPTION OF HOW THE INDEPENDENT REVIEW OF DR/CT SCANS MEETS PERMIT REQUIREMENTS AS A QC CHECK
ON RADIOGRAPHY

REQ.	Permit Section	Permit Text	How DR/CT Data Meets Requirements
PHYSICAL FORM	B-3c; B-3d; B1-3b(1)	Radiography and/or visual examination will be used to examine every waste container to verify its physical form . (B-3c) Radiography and/or VE will be used to verify the physical form of retrievably stored TRU mixed waste. (B-3d) Radiography of Waste Forms (B1-3b(1))	High energy and/or high sensitivity DR/CT is a form of radiography which allows more penetration of the waste container; more definition of the container contents and the ability of the operator to review data more frequently without having to re-radiograph the container. DR/CT operators have been able to consistently and accurately determine the physical form of the waste (Note 4)
PROHIBITED ITEMS (Note 1)	B-3c	These techniques can detect liquid wastes and containerized gases , which are prohibited for WIPP disposal. (B-3c)	DR/CT employs three axes of motion—elevation, rotation and tilt. The tilt function allows the container to be tilted while it is being radiographed. This tilt allows the operator/data reviewer to determine if free liquids are present. The difference in densities between air and liquid is such that when employing DR/CT it is obvious to the operator/data reviewer when liquids or containerized gases (aerosol cans) are present. Possessing an imaging pixel size of 1 millimeter or less with a high dynamic range detector the system is designed to image both light weight and dense materials in the same image. (Note 4)
RCRA ITEMS (Note 2)	B-3d	Radiography and/or VE, and the associated information compiled from acceptable knowledge (e.g., age of the waste, generating process) will be used to determine the RCRA-regulated constituents present in the waste. (B-3d)	RCRA items are not directly identifiable through any of the techniques (RTR, VE or DR/CT). However, when used in conjunction with AK the identification of RCRA items can be accomplished by all of these techniques.
PROCEDURES (Note 3)	B1-3a	The Permittees shall require that sites describe all activities required to achieve the radiography objectives in site QAPjPs and SOPs . SOPs should also include instructions specific to the radiography method(s) used at respective facilities. For example, to detect liquids some systems require the drum to be moved, while in other systems the drums require tilting. These details should be addressed in site SOPs. (B1-3a)	Specific procedures are required for all techniques (RTR, VE and DR/CT). These procedures are or will be in place to assure that all work is performed in a systematic manner and that all required actions take place.
MATERIAL PARAMETER WEIGHTS	B1-3a; B1-3b(3)	A radiography data form is also used to document the Waste Matrix Code and estimated waste material parameter weights of the waste.(B1-3a) This verification shall include the Waste Matrix Code and waste material parameter weights . (B1-3b(3))	Using DR/CT an operator can distinguish between items of varying densities and therefore can be used to assign estimated material parameter weights based upon those variations in density. The DR/CT process and operators have undergone 4 DOE audits and successfully completed the RCI. Using trained operators, the DR/CT system was shown to be sufficient to meet all accuracy requirements for three surrogate and five actual drum content codes and matrices under the RCI program (Note 4)

INVENTORY OF ITEMS	B1-3a; B1-3b(3)	The estimated waste material parameter and weights should be determined by compiling an inventory of waste items, residual materials, and packaging materials. (B1-3a) Visual examination shall be conducted to describe all contents of a waste container , and includes estimated or measured weights of the contents. (B1-3b(3))	DR/CT is an approved form of radiography and can currently be used to characterize TRU and TRU mixed wastes. DR/CT surpasses current RTR capabilities. The high-energy and/or high sensitivity system enables the operator to identify items in the containers regardless of waste density or packaging. High-energy and/or high sensitivity DR/CT system can supply the operator with thin slice-planes (circular cross-sectional images of a drum) allowing identification of drum contents and distinguishing matrix density variations within the drum. Using CT, the operator can stack the slices together to present cut-away cinematic rotating volume rendering views of a drum for non-invasive VE. Because the DR/CT operator can distinguish between items of varying densities an estimation of material parameter weights can be made. (Note 4)
DENSE ITEMS	B1-3a	Containers whose contents prevent full examination to the extent expected for the radiography technique and waste form, shall be subject to visual examination. (B1-3a)	Operators using DR/CT have demonstrated the ability to see through lead lined drums; pipe overpacks; opaque items; poly bags and liners; dense sludge and cement. The latter two physical forms would not be viewable with VE. (Note 4)
RECORD	B1-3b(3)	If acceptable knowledge is insufficient for individual bags/packages, actual weights of waste items, residual materials, packaging materials, or waste material parameters shall be recorded. All visual examination activities shall be documented on video/audio tape and the results of all visual examination shall be documented on visual examination data forms. The visual examination shall consist of a semi-quantitative and/or qualitative evaluation of the waste container contents, and shall be recorded on audio/videotape. (B1-3b(3))	DR/CT systems are equipped with optical disc for data storage and digital audio is available to accompany the optical disc.
OPAQUE ITEMS	B1-3b(3)	It may not be possible to see through inner bags because of discoloration, dust, or because inner containers are sealed. In these instances, documented acceptable knowledge may be used to identify the matrix parameter category and estimated waste material parameter weights. (B1-3b(3))	Operators using DR/CT have demonstrated the ability to see through lead lined drums; pipe overpacks; opaque items; poly bags and liners; dense sludge and cement. The latter two physical forms would not be viewable with VE. (Note 4)

Note 1 Prohibited items are residual liquids and unvented containerized gases (aerosol cans). Others are only identifiable through "indicators".

Note 2 RCRA items not directly identifiable with any of the techniques listed. Radiography and VE support the confirmation of AK that may be associated with RCRA items.

Note 3 All sites are required by the permit to have standard operating procedures for each specific method employed.

Note 4 Additional data and documentation showing the capabilities of DR/CT can be found at the Internet addresses shown in Attachment B.

Benefits From Using An Independent Interpretation of DR/CT Data Instead of VE

1. The number of containers that are opened is minimized consistent with 20.4.1.500 NMAC (incorporating 40 CFR 264, Subpart I)

The HWFP requires the DOE to open containers to obtain characterization data or to confirm data used to characterize the waste. It is the DOE's responsibility to perform such activity in a manner that meets the human health and environmental protection goals of the regulations. The requested modification to provide QC of radiography by independent interpretation of scans when using DR/CT provides an alternative to opening containers and thereby reduces the potential for exposure or releases. This approach is allowed and encouraged by the hazardous waste regulations.

2. The approach in this modification is a direct response to the fundamental objectives outlined in the Joint EPA/NRC Guidance for Mixed Radioactive Waste

The Joint EPA/NRC Guidance for Mixed Radioactive Waste (Federal Register, Volume 62, Number 224, November 20, 1997, page 62079) states "EPA and NRC are aware of the potential hazards attributable to testing hazardous waste. Moreover, EPA and NRC recognize that the radioactive component of mixed waste may pose additional hazards to laboratory personnel, inspectors, and others who may be exposed during sampling and analysis. All sampling and analysis should be conducted in accordance with procedures that minimize exposure to radiation and ensure personnel safety."

This document further states, "Mixed waste is unique for its radioactive/hazardous composition and dual management requirements. Each sampling or analytical event involving mixed waste may result in an incremental exposure to radiation, and EPA's responsibility to protect human health and the environment must show due regard for minimizing this unique risk."

3. This approach minimizes additional TRU mixed waste generated during VE

Generator sites engaged in VE activities generate additional mixed waste as a result of the VE process. Estimated rates of additional waste generated range from one additional drum for every three drums opened for VE, to one additional drum for every 20 drums opened for VE. The requested modification will reduce the generation of VE-related waste.

4. This modification reduces potential radiation exposures to waste characterization workers.

Within 10 CFR § 835.2 (a)(2), ALARA is defined as: "As Low As Reasonably Achievable, which is the approach to radiation protection to manage and control exposures (both individual and collective) to the work

force and to the general public to as low as is reasonable, taking into account social, technical, economic, practical and public policy considerations.” Further in 10 CFR § 835.1001 (a), it states “Measures shall be taken to maintain radiation exposure in controlled areas ALARA through physical design features and administrative controls.” Once again 10 CFR § 835.1003 (b) states, “During routine operations the combination of physical design and administrative controls shall provide that the ALARA process is utilized for personnel exposures to ionizing radiation.” The DOE, while complying with the HWFP, must also consider the ALARA impact of every action taken.

The Joint NRC/EPA Guidance on Testing Requirements for Mixed Radioactive Waste (Federal Register, Volume 62, Number 224, November 20, 1997, page 62079) states that “Flexibility in the RCRA requirements is emphasized so that As Low As Reasonably Achievable (ALARA) concept can be incorporated into the mixed waste testing activities.”

The National Academy of Sciences (NAS) National Research Council Report entitled “Improving Operations and Long-Term Safety of the Waste Isolation Pilot Plant” April 2000 states: that ALARA requires that all operations be done with the lowest possible radiation exposure consistent with other requirements of safety and basic programmatic objectives as mandated by DOE Order 435.1.

This modification facilitates meeting the DOE, EPA/NRC, and NAS goals consistent with NMED’s hazardous waste management program.

5. This approach minimizes opportunities for accidental exposure of VE operators

The *Occurrence Reporting and Processing System (ORPS)* is the computerized implementation of the DOE’s Occurrence Reporting Program, which provides timely notification to the DOE complex of events that could adversely affect:

- public or DOE worker health or safety
- the environment
- national security
- DOE’s safeguards and security interests
- functioning of DOE facilities

A search of the ORPS to determine the number of incidents and exposures which resulted from glovebox operations or visual examinations showed that, over the last several years, several exposures occurred as a direct result of torn gloves, equipment failure, or similar uncontrollable events. During the same time frame, the number of incidents and exposures which resulted from radiographic examination

was zero (0).

Conclusion

The intent of this modification request has been to show that the independent review of DR/CT scans meets all of the HWFP criteria as a QC check of radiography. Consequently, the Permittees request that the HWFP be modified to allow the use of the independent review of DR/CT scans as set forth below in the Revised Permit Text.

Revised Permit Text:

a. 1. Module II

Statistical methods used in sampling and analysis - the Permittees shall require that generator/storage sites use the methods for statistically selecting retrievably stored and newly-generated TRU mixed waste containers for ~~visual examination~~, **QC of radiography** and volatile organic compounds (**VOCs**), semivolatile organic compounds (**SVOCs**), and total metals analysis, establishing upper confidence limits, and control charting for newly-generated waste stream sampling specified in Permit Attachment B2 (Statistical Methods Used in Sampling and Analysis).

b.1. Attachment B-1c

Before accepting a container holding TRU mixed waste, the Permittees will ensure, through audit and as part of their Permittee-level data reviews (B3-10c), that generator/storage sites examine the radiography, **QC of radiography** or visual examination data ~~records~~ **forms** (~~refer to~~ Section B-4b) to verify that the container holds no unvented compressed gas containers and that residual liquid does not exceed 1 percent volume in any payload container. If discrepancies or inconsistencies are detected during the data form review, the generator/storage site will review the radiography video/~~audio tape~~ **data** (i.e. **video tape or digital record**) or visual examination tape to verify that the observed physical form of the waste is consistent with the waste stream description provided by the generator and to ensure that no prohibited items are present in the waste. Radiography ~~tapes~~ **video/audio data** will be selected randomly from at least one percent of containers received at WIPP and will be reviewed and compared to radiographic data forms. All personnel who review radiography video/~~audio tapes~~ **data** will be trained to the same standard as radiography operators. Section B-4 includes a description of the waste verification process that the Permittees will conduct prior to receiving a shipment at the WIPP facility.

b. 2. Attachment B-3c

Generator/storage sites may conduct visual examination of waste containers in lieu of radiography. For generator/storage sites that choose to use visual examination in lieu of radiography, the detection of any liquid waste in non-transparent inner containers, detected from shaking the container, will be handled by assuming that the container is filled with liquid and adding this volume to the total liquid in the payload container (e.g., 55 gallon drum or SWB). The payload container would be rejected and/or repackaged to exclude the container if it is over the TSDF-WAC limits. When radiography is used, or visual

examination of transparent containers is performed, if any liquid in inner containers is detected, the volume of liquid shall be added to the total for the payload container. Radiography, or the equivalent, will be used on the existing/stored waste containers to verify the physical characteristics of the TRU mixed waste correspond with its waste stream identification/waste stream Waste Matrix Code and to identify prohibited items. The results of radiography are verified through ~~visual examination~~ **QC of radiography as described in Attachment B1-3b(3) on** of a statistically selected subpopulation of TRU mixed waste containers in each TRU mixed waste summary category group ~~as using the approach~~ specified in Permit Attachment B2 **to establish the verification rate**. Radiographic examination protocols and QA/QC methods are provided in Permit Attachment B1.

b. 3. Attachment B-3d(2)

To confirm the results of radiography, ~~a statistically selected number of the TRU mixed waste containers are randomly selected~~ population will be visually examined by opening containers to inspect waste contents **to undergo a QC check of the initial radiography** to verify radiography results **as described in Attachment B1-3**. Permit Attachment B2 contains the approach used to statistically ~~select~~ **determine the number of rate at which** drums to **will** be visually examined **randomly selected for verification**. For homogenous waste and soils/gravels selected for sampling, the containers opened for sampling may be used to help fulfill the ~~visual examination~~ **confirmation of radiography** requirements. A site **that used VE to confirm radiography results** may establish container safety conditions that must be met prior to opening containers for VE as a QC check on radiography. The establishment and use of container safety conditions are subject to the following criteria:

Representativeness of containers selected for ~~visual examination~~ **QC of radiography** and waste subjected to homogeneous solids and soil/gravel sampling and analysis will be validated by the generator/storage site and by the Permittees during an audit (Permit Attachment B6) via examination of documentation that shows that true random samples were collected.

b. 4. Attachment B-4a(1)

c Visual Examination

- To verify the TRU mixed waste streams by Waste Matrix Code for purposes of physical waste form identification, determination of sampling and analytical requirements, and to identify prohibited items.
- To provide a process check on a sample basis by verifying the information determined by radiography, and to confirm the waste stream delineation by acceptable knowledge. **(Applies only to sites that use VE as a QC check of radiography)**

b. 5. Table B-6

TABLE B-6 (CONTINUED)
SUMMARY OF PARAMETERS, CHARACTERIZATION METHODS, AND RATIONALE
FOR CH TRANSURANIC MIXED WASTE (STORED WASTE)

Waste Matrix Code Summary Categories	Waste Matrix Code Groups	Characterization Parameter	Method	Rationale
S5000–Debris Waste	C Uncategorized metal (metal waste other than lead/cadmium) C Lead/cadmium waste C Inorganic nonmetal waste C Combustible waste C Graphite waste C Heterogeneous waste C Composite filter waste	Physical waste form	100% Radiography Visual examination (statistical sample)* or visual examination	C Verify waste matrix C Demonstrate compliance with waste acceptance (e.g., no free liquids, no incompatible wastes, no compressed gases)
		Headspace gases C Gas VOCs	100% gas sampling and analysis or statistical sampling (see Table B-3)	C Quantify concentration of flammable VOCs C Determine potential flammability of TRU mixed waste headspace gases C Quantify concentrations of VOC constituents in headspace of containers C Ensure that environmental performance standards are not exceeded C Verify acceptable knowledge
		Hazardous constituents C TCLP/total metals C TCLP/total VOCs C TCLP/total semi-VOCs	Acceptable knowledge	C Determine characteristic metals and organics C Determine total quantity of metals, VOCs, and semi-VOCs

b. 6. Figure B-3

The revised Figure B-3 is included in Attachment C

b. 7. Table B-7

The revised Table B-7 is included in Attachment C

c. 1. Attachment B1

TABLE OF CONTENTS

List of Tables	B1-iii
List of Figures	B1-iii
Introduction	B1-1
B1-1 Headspace-Gas Sampling	B1-1
B1-1a Method Requirements	B1-1
B1-1a(1) Manifold Headspace Gas Sampling	B1-2
B1-1a(2) Direct Canister Headspace Gas Sampling	B1-5
B1-1a(3) Sampling Heads	B1-6
B1-1a(3)(i) Sampling Through the Carbon Filter	B1-6
B1-1a(3)(ii) Sampling Through the Drum Lid	B1-7
B1-1b Quality Control	B1-8
B1-1b(1) Field Blanks	B1-9
B1-1b(2) Equipment Blanks	B1-9
B1-1b(3) Field Reference Standards	B1-9
B1-1b(4) Field Duplicates	B1-10
B1-1c Equipment Testing, Inspection and Maintenance	B1-10
B1-1c(1) Headspace-Gas Sample Canister Cleaning	B1-10
B1-1c(2) Sampling Equipment Initial Cleaning and Leak Check	B1-11
B1-1c(3) Sampling Equipment Routine Cleaning and Leak Check	B1-11
B1-1c(4) Manifold Cleaning After Field Reference Standard Collection	B1-12
B1-1c(5) Sampling Head Cleaning	B1-12
B1-1d Equipment Calibration and Frequency	B1-12
B1-2 Sampling of Homogenous Solids and Soil/Gravel	B1-12
B1-2a Method Requirements	B1-12
B1-2a(1) Core Collection	B1-13
B1-2a(2) Sample Collection	B1-15
B1-2b Quality Control	B1-16
B1-2b(1) Co-located Samples	B1-16
B1-2b(2) Equipment Blanks	B1-17
B1-2b(3) Coring Tool and Sampling Equipment Cleaning	B1-18
B1-2c Equipment Testing, Inspection and Maintenance	B1-19
B1-2d Equipment Calibration and Frequency	B1-20
B1-3 Radiography	B1-20
B1-3a Methods Requirements	B1-20
B1-3b Quality Control	B1-21
B1-3b(1) Formal Training	B1-22
B1-3b(2) On-the-Job Training	B1-22
B1-3b(3) Visual Examination Confirmation of Radiography	B1-23
B1-3b(4) Formal Training	*B1-24
B1-3b(5) On-the-Job Training	*B1-25
B1-4 Custody of Samples	*B1-25

B1-5 Sample Packing and Shipping	*B1-26
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B1-6 List of References	*B1-28
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* Page numbers to be determined

c. 2 Attachment B1-3a

Radiography has been developed by the Permittees specifically to aid in the examination and identification of containerized waste. There is no equivalent or associated method found in EPA sampling and analysis guidance documents. The Permittees shall require that sites describe all activities required to achieve the radiography objectives in site QAPjPs and SOPs. SOPs should also include instructions specific to the radiography method(s) used at respective facilities. For example, to detect liquids some systems require the drum to be moved, while in other systems the drums require tilting. These details should be addressed in site SOPs.

A radiography system (e.g., ~~digital~~ Real Time-Radiography, **digital radiography (DR)** and computed tomography (**CT**)) normally consists of an X-ray-producing device, an imaging system, an enclosure for radiation protection, a waste container handling system, an ~~audio/video~~ **video/audio data** recording system (i.e. **video/audio tape or digital records**), and an operator control and data acquisition station. Although these six components are required, it is expected there will be some variation within a given system between sites. The radiography equipment shall have controls or an equivalent process which allow the operator to control image quality. For instance, on some radiography equipment it should be possible to vary the voltage, typically between 150 to 400 kilovolts (**kV**), to provide an optimum degree of penetration through the waste. For example, high-density material should be examined with the X-ray device set on the maximum voltage. This ensures maximum penetration through the waste container. Low-density material should be examined at settings to improve contrast and image definition. The imaging system typically utilizes a fluorescent screen, a low-light television camera or x-ray detectors to generate the image.

To perform radiography, the waste container is scanned while the operator views the television screen. An audio/videotape or equivalently non-alterable media **or a digital record** is made of the waste container scan and is maintained as a non-permanent record. A radiography data form is also used to document the Waste Matrix Code and estimated waste material parameter weights of the waste. The estimated waste material parameter and weights should be determined by compiling an inventory of waste items, residual materials, and packaging materials. The items on this inventory should be sorted by waste material parameter and combined with a standard weight look-up table to provide an estimate of waste material parameter weights. Containers whose contents prevent full examination to the extent expected for the radiography technique and the waste form shall be subject to visual examination.

c. 3 Attachment B1-3b(2)

Independent replicate scans and replicate observations of the video output of the radiography process, **or independent reviews of the DR/CT scans** shall be performed under uniform conditions and procedures. **Except for DR/CT scans,**

Independent replicate scans shall be performed on one waste container per day or once per testing batch, whichever is less frequent; ~~and an~~ independent observations of one scan (not the replicate scan) shall also be made once per day or once per testing batch, whichever is less frequent, by a qualified radiography operator other than the individual who performed the first examination. A testing batch is a suite of waste containers undergoing radiography using the same testing equipment. A testing batch can be up to 20 waste containers without regard to waste matrix. ~~For those sites that use DR/CT, an independent review of the DR/CT scan results will be performed at the frequency of two randomly selected containers per batch of up to 20 containers initially radiographed or per day, whichever is less frequent.~~

Oversight functions include periodic ~~audio/video-tape~~ ~~video/audio data~~ reviews of accepted waste containers and shall be performed by qualified radiography personnel other than the operator who dispositioned the waste container. The results of this independent verification shall be available to the radiography operator. The Permittees shall require the site project QA officer to be responsible for monitoring the quality of the radiography data and calling for corrective action, when necessary.

c. 4 Attachment B1-3b(3)

B1-3b(3) ~~Visual Examination~~ Confirmation of Radiography

As an additional QC check, ~~or in lieu of radiography,~~ the waste container contents shall be verified by one of the following methods. ~~directly by visual examination of the waste container contents.~~

6. Visual examination (B1-3b(3)(i)) or
7. DR/CT (B1-3b(3)(ii)) with a
8. Performance Evaluation Program (B1-3b(3)(iii))

In all cases, the generator/storage sites shall describe the method in the QAPjP and standard operating procedures as appropriate.

B1-3b(3)(i) Visual Examination

Visual examination as specified in this Section may be used in lieu of radiography. Visual examination shall be performed on a statistically determined portion of waste containers to verify the results of radiography. With the exception of items or conditions that could pose a hazard to visual examination personnel, the radiography results shall not be made available until after the visual examination is completed. This verification shall include the Waste Matrix Code and waste material parameter weights. The verification shall be performed through a comparison of radiography and visual examination results. The Waste Matrix Code is determined and waste material parameter weights are estimated to verify that the container is properly included in the appropriate waste stream. The results of the visual examination shall be transmitted to the radiography facility.

Visual examination shall be conducted to describe all contents of a waste container, and includes estimated or measured weights of the contents. The description shall clearly identify all discernible waste items, residual materials,

packaging materials, or waste material parameters. Visual examination experts who are experienced and trained shall assess the need to open individual bags or packages of waste. If individual bags/packages are not opened, estimated weights shall be recorded. Estimated weights shall be established through the use of historically derived waste weight tables and an estimation of the waste volumes. It may not be possible to see through inner bags because of discoloration, dust, or because inner containers are sealed. In these instances, documented acceptable knowledge may be used to identify the matrix parameter category and estimated waste material parameter weights. If acceptable knowledge is insufficient for individual bags/packages, actual weights of waste items, residual materials, packaging materials, or waste material parameters shall be recorded. All visual examination activities shall be documented on video/audio tape and the results of all visual examination shall be documented on visual examination data forms.

The visual examination shall consist of a semi-quantitative and/or qualitative evaluation of the waste container contents, and shall be recorded on audio/videotape. ~~The visual examination program has been developed by the Permittees to provide an acceptable level of confidence in radiography.~~ There is no equivalent method **to visual examination** found in EPA sampling and analysis guidance documents. The specific requirements of visual examination are described in this WAP.

Standardized training for visual inspection shall be developed to include both formal classroom training and OJT. Visual inspectors shall be instructed in the specific waste generating processes, typical packaging configurations, and expected waste material parameters expected to be found in each Waste Matrix Code at the site. The OJT and apprenticeship shall be conducted by an operator experienced and qualified in visual examination prior to qualification of the candidate. The training shall be site specific to include the various waste configurations generated/stored at the site. For example, the particular physical forms and packaging configurations at each site will vary so operators shall be trained on types of waste that are generated, stored, and/or characterized at that particular site. Visual examination personnel shall be requalified once every two years.

B1-3b(3)(ii) Review of Digital Radiograph Scans

For those facilities using digital radiography (DR/CT), the QC requirements can be met with an independent review of the digital record of the container which is performed by an equally trained operator (i.e., a second scan of the container is not required). The independent review will occur on 2 randomly selected containers per batch which will undergo radiography or 2 randomly selected containers per day whichever is less frequent. The Attachment B2-1 methodology for determining the miscertification rate and the required sampling rate will apply except that the sampling rate will never be less than that specified in this paragraph.

Standardized training requirements for radiography operators shall be based upon existing industry standard training requirements and shall comply with the training and qualification requirements stipulated in this WAP (Section B1-3b).

In this context, the term "industry standard" refers to a consensus standard used

by industry to define the scope and content of training programs. One such standard that is used is the American Society of Nondestructive Testing (ASNT) SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing. Data summary reports cannot be compiled until the project level data validation and verification has been completed. The requirement for validating and verifying the data summary package and waste stream characterization summary package at the project level was revised to refer to the batch data reports. The specific batch information required to be validated and verified is in the batch data reports. The data summary reports are compiled at the project level and must include the site project QA officer summary and data validation summary; therefore, must be compiled after data are validated and verified. The reason that "industry standards" are used is because there are no equivalent specific RCRA or EPA training standards for radiography. Therefore, the NMED relies on those that are established as generally accepted industry standards.

In the case of the requirement in Section B-1c, the NMED states that "... All personnel who review radiography video tapes will be trained to the same standard as radiography operators. ..." This is interpreted to mean that in identifying the training requirements for each person that has a responsibility with regard to radiography, the appropriate portions of an industry standard are to be implemented and that the same industry standard is to be used for all radiography programs. Therefore, the individuals responsible for checking one percent of the radiography tapes (referred to herein as radiography reviewers) must have appropriate training. The permit requires that training be defined in site specific documents. In other words, when defining what level of training is appropriate for the radiography reviewer, the Permittees need to consider the same training standard that is used for the definition of the appropriate training for radiography operators. The training itself need not be identical. If the NMED had intended that the radiography reviewer have identical training, then statements similar to those in Section B-3d(1) which specifically state that the second person be "equally trained to the requirements stipulated in Permit Attachment B3" would be included.

The review of digital radiography scans shall be subject to the Permittees' Audit and Surveillance Program (Permit Attachment B6).

B1-3b(3)(iii) Performance Evaluation Program

The Performance Evaluation Program must be used if DR/CT is used as the QC method in Attachment B1-3b(3)(ii).

The Performance Evaluation Program is a site specific program because the waste types, forms and configurations will vary among the various generator/storage sites. The Performance Evaluation Program will consist of at least two Performance Evaluation Program drums per Summary Category Group that must be scanned on a quarterly basis. These drums must be evaluated by each qualified operator.

Performance Evaluation Program drums shall include items common to the TRU and TRU mixed waste streams to be generated/stored at the generator/storage site. The Performance Evaluation Program testing drums shall be divided into layers with varying packing densities or different drums may be used to represent different situations that may occur during radiography examination at

the site. Test drums representative of the applicable Summary Category Groups must be examined and the contents successfully identified.

The test drums must be reconfigured each quarter (i.e., the contents varied) to ensure variability in the testing program. The test drums must contain 6 or more of the following items, singly or in multiples:

- Aerosol can with puncture
- C Horsetail bag
- C Pair of coveralls
- C Empty bottle
- C Irregular shaped pieces of wood
- C Empty one gallon paint can
- C Full container
- C Aerosol can with fluid
- C One gallon bottle with three tablespoons of fluid
- C One gallon bottle with one cup of fluid (upside down)
- C Leaded glove or leaded apron
- C Wrench

Performance Evaluation Program drums must be repackaged each time to assure variability.

A visual record of the contents of these drums may be created at the time of filling, or as an analogy to VE may be created after the tests. The results of the DR/CT scan and interpretation will be compared directly to the visual record created for each of the Performance Evaluation Program drums. Failure to identify any of these objects that are present in a Performance Evaluation Program drum or to identify the physical waste form is considered unsatisfactory performance and appropriate corrective action must be taken as addressed in Section B3-4.

Implementation of the Performance Evaluation Program at the generator/storage sites is the responsibility of the Site Project Manager (SPM). All necessary changes to the generator/storage sites QAPjP to implement the Performance Evaluation Program will be the responsibility of the SPM.

c. 5. Attachment B1-3b(5)

Figure B1-6 illustrates the overall programmatic approach to the visual examination of waste. If the waste is homogeneous, the expert may decide that a limited visual examination involving a confirmation of the radiography data is appropriate. This Figure applies when VE is used as the QC of radiography.

d. 1. Attachment B2

TABLE OF CONTENTS

List of Tables	B2-ii
List of Figures	B2-ii

Introduction	B2-1
B2-1 Approach for Statistically Selecting Waste Containers for Visual Examination QC of Radiography	B2-1

List of Tables

Table	Title
B2-1	Number of Waste Container Requiring Visual Examination Selected for QC of Radiography

d. 2. Attachment B2

The Permittees shall require generator/storage sites (**sites**) to use the following statistical methods for sampling and analysis of TRU mixed waste which is managed, stored, or disposed at WIPP. These statistical methods include methods for selecting waste containers for ~~visual inspection~~ **QC of radiography**, selecting retrievably stored waste containers for totals analysis, setting the upper confidence limit, and control charting for newly generated waste stream sampling.

d. 3. Attachment B2-1

B2-1 Approach for Statistically Selecting Waste Containers for ~~Visual Examination~~ **QC of Radiography**

As a Quality Control check on the radiographic examination of waste containers, a ~~statistically selected~~ portion of the certified waste containers **selected in accordance with the statistical approach in this Attachment** must be opened and ~~visually examined~~ **be used to verify the quality of the initial radiographic examination**. The data from ~~visual examination~~ **this QC check of the initial radiographic examination** shall be used to verify the matrix parameter category, waste material parameter weights, and absence of prohibited items as identified in Attachment B, Section B-1c, as determined by radiography.

The data obtained from the ~~visual examination~~ **QC of radiography** shall also be used to determine, with acceptable confidence, the percentage of miscertified waste containers from the radiographic examination. Miscertified containers are those that radiography indicates meet the Waste Isolation Pilot Plant Waste Acceptance Criteria and Transuranic Package Transporter-II Authorized Methods for Payload Control but ~~visual examination~~ **the quality control review** indicates do not meet these criteria.

Participating sites shall initially use an eleven-percent (11%) miscertification rate to calculate the number of waste containers that shall ~~be visually examined~~ **undergo QC of radiography** until a site-specific miscertification rate has been established. Sites may establish a site-specific miscertification rate by characterizing a lot of no less than fifty containers in a single Summary Category Group at the initial 11% miscertification rate. The results of this initial characterization shall then serve as the site-specific miscertification rate until reassessed annually as described below.

The site-specific miscertification rate shall be applied initially to each Summary Category Group to determine the number of containers in that Summary Category Group requiring ~~visual examination~~ **QC of the radiographic examination**, as specified in Table B2-1. However, a Summary Category Group-specific miscertification rate shall be determined when either six months have passed since radiographic characterization commenced on a given Summary Category Group or at least 50% of a given Summary Category Group has undergone radiographic characterization, whichever occurs first. The Summary Category Group shall then be subject to the ~~visual examination~~ **QC of radiography** requirements of this reevaluated Summary Category Group-specific miscertification rate to ensure that the entire Summary Category Group is appropriately characterized. Table B2-1 provides the number of waste containers per Summary Category Group that shall ~~be visually examined~~ **undergo a QC of radiography** for various miscertification rates and waste container population sizes using a hypergeometric sampling approach. Sites **performing visual examination** shall use a miscertification rate of 1% for any Summary Category Group-specific miscertification rate calculated to be less than 1%. **A site with a miscertification rate established under this WAP may use that rate for either QC method. However sites using a review of DR/CT digital records as a QC check on radiography shall perform no fewer than 2 independent reviews per batch or 2 independent reviews per day, whichever is fewer.**

The site-specific **and Summary Category Group** miscertification rate shall be reassessed annually by calculating a drum-weighted average of all historic Summary Category Group-specific miscertification rates. Each Summary Category Group-specific miscertification rate shall be rounded off to the nearest integer value before being used to calculate the new site-specific miscertification rate. Sites shall use a miscertification rate of 1% for any site-specific miscertification rate calculated to be less than 1% **except that those sites using a review of DR/CT digital records as a QC check on radiography shall perform no fewer than 2 independent reviews per 20 containers or 2 independent reviews per day, whichever is fewer..**

Table B2-1 has been developed with the use of an EG&G Idaho, Inc. engineering design file (EG&G 1994). The number of waste containers requiring ~~visual examination~~ **QC of radiography** is based on a 90 percent confidence that the actual miscertification rate (for the population) is less than the 90 percent upper confidence level (**UCL**), and also an 80 percent confidence that the UCL will be less than 14 percent if the actual miscertification rate is the same as the targeted percent of miscertified waste containers (column heading of Table B2-1). Thus, there is only a 10 percent probability that the UCL will be below 14 percent in the case where the actual miscertification rate is 14 percent or greater. Also, there is only a 20 percent probability that the UCL will be above 14 percent in the case where the actual miscertification rate is the same as the targeted percent.

The hypergeometric approach to determining the number of containers ~~to be visually examined~~ **subject to QC of radiography** is dependant upon the defined estimate of the allowable proportion of containers that were miscertified and information on previous percentages of containers that were miscertified.

d. 4. Table B2-1

TABLE B2-1
NUMBER OF WASTE CONTAINERS REQUIRING VISUAL EXAMINATION SELECTED FOR QC OF RADIOGRAPHY

Annual Number of Waste Containers per Summary Category Group Undergoing Characterization	Number of Waste Containers Requiring Visual Examination Selected For QC of Radiography Based on Percent of Waste Containers Miscertified to WIPP-WAC by Radiography in Previous Year(s)													
	1% or less	2%	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14% or greater
50 or less	22 ^a	22	22 ^a	22	29 ^a	29	41 ^a	41	46 ^a	46	50 ^a	50	50 ^a	50
100	15	24	24	33	33	41	48	62	69	81	87	96	100	100
200	15	26	26	35	44	52	68	83	105	126	152	176	196	200
300	15	26	26	35	44	53	70	94	116	153	202	247	287	300
400	15	26	26	36	45	62	79	103	134	178	235	316	377	400
500	16	26	26	36	45	63	80	104	143	196	268	364	465	500
1000	16	27	27	36	46	64	81	114	162	239	359	568	848	1000
1500	16	27	27	37	46	64	81	123	171	257	416	701	1176	1500
2000	16	27	27	37	46	64	90	123	172	266	441	795	1453	2000

^a Number of containers for the higher even-number percent of miscertified containers is used because an odd percent implies a noninteger number of containers are likely to be miscertified.

d. 5. Equation B2-3

Note that in Equation B2-3, the upper confidence limit is dependent on x, the number of miscertifications observed in the sample, as well as on n, the sample size. To obtain the required sample size, the values of x that are likely to be seen shall also need to be considered. Sample size that shall ~~be visually examined~~ **undergo a QC of radiography** shall be determined by setting a desired upper confidence limit value and then manipulating x and n in Equation B2-3.e.

e.1. Attachment B3-1

B3-1 Validation Methods

The Permittees shall require the generator/storage sites (**sites**) to perform validation of all data (qualitative as well as quantitative) so that data used for Waste Isolation Pilot Plant (**WIPP**) compliance programs will be of known and acceptable quality. Validation includes a quantitative determination of precision, accuracy, completeness, and method detection limits (as appropriate) for analytical data (headspace Volatile Organics Compounds (**VOC**), total VOCs, Semivolatile Organic Compounds (**SVOC**), and metals data). Quantitative data validations shall be performed according to the conventional methods outlined below (equations B3-1 through B3-8). These quantitative determinations will be compared to the Quality Assurance Objectives (**QAOs**) specified in Sections B3-2 through B3-9. A qualitative determination of comparability and representativeness will also be performed.

The qualitative data or descriptive information generated by radiography (**analog or digital**), and visual examination ~~is~~ **are** not amenable to statistical data quality analysis. However, radiography (**analog or digital**), and visual examination are complementary techniques yielding similar data for determining the waste matrix code and waste material parameter weights of waste present in a waste container. Therefore, visual examination ~~or digital radiography/computed tomography~~ results shall be used to verify the waste matrix code and waste material parameter weights determined by radiography. The waste matrix code is determined and waste material parameter weights are estimated to verify that the container is properly included in the appropriate waste stream.

e. 2. Attachment B3-4

Precision

The qualitative determinations, such as verifying the waste matrix code, made during radiography do not lend themselves to statistical evaluation of precision because of the qualitative nature of the inspection. ~~However, comparison of data derived from radiography and visual examination on the same waste containers at the Rocky Flats Environmental Technology Site and the Idaho National Engineering Laboratory indicates that radiography operators can provide estimated inventories and weights of waste items in a waste container.~~ As a measure of precision, the Permittees shall require each Site Project QA Officer to calculate and report the RPD between the estimated waste material parameter weights as determined by radiography and these same parameters as determined by ~~visual examination~~ **a QC check of a radiographic examination**. Additionally, the precision of radiography is verified prior to use by tuning

precisely enough to demonstrate compliance with QAOs through viewing an image test pattern.

Accuracy

The programmatic accuracy at which the waste matrix code and waste material parameter weights can be determined must be documented through ~~visual examination~~ **a QC check of a radiographic examination on** of a randomly selected ~~statistical~~ portion of waste containers. The Permittees shall require the Site Project QA Officer to calculate and report the miscertification rate of waste containers that require assignment to a different waste matrix code or are found to contain prohibited items ~~after visual examination~~ **as a result of a QC check of a radiographic examination**. ~~as a measure of radiography accuracy~~. The miscertification rate shall be used to determine the number of drums subject to **a QC check of a radiographic examination** ~~confirmatory visual examination~~.

e. 3. Attachment B3-9

The Permittees shall require each site to address quality control by tracking its performance with regard to the use of acceptable knowledge by: 1) assessing the frequency of inconsistencies among information, and 2) documenting the results of acceptable knowledge confirmation through radiography, ~~and/or~~ visual examination, headspace-gas analyses, and solidified waste analyses. In addition, the acceptable knowledge process and waste stream documentation must be evaluated through internal assessments by quality assurance organizations and assessments by auditors external to the organization (i.e., the Permittees).

e. 4. Attachment B3-10a(1)

! Radiography tapes ~~or DR/CT scans~~ have been reviewed (independent observation) **at the appropriate frequency in accordance with** ~~on a waste container basis at a minimum of once per testing batch or once per day of operation, whichever is less frequent (Section B1-3b(2)). The radiography tape will be reviewed against the data reported on the radiography form to ensure that the data are correct and complete.~~

e. 5. Attachment B3-10a(2)

All data have received independent technical review with the exception of radiography tapes ~~or DR/CT scans~~, which shall receive periodic technical review as specified in Section B1-3b(2).

e. 6. Attachment B3-10b(1)

Testing batch QC checks (e.g., replicate scans, measurement system checks,) were properly performed. Radiography data are complete and acceptable based on evidence of videotape ~~or DR/CT scans~~ review **at the appropriate frequency in accordance with** ~~of one waste container per day or once per testing batch, whichever is less frequent, as specified in B1-3b(2).~~

e. 7. Attachment B3-11a

For each waste stream characterized, the Permittees shall require each Site Project Manager to determine if sufficient data have been collected to determine the following WAP-required waste parameters:

- ! Waste matrix code
- ! Waste material parameter weights
- ! If each waste container of waste contains TRU radioactive waste
- ! Mean concentrations, UCL_{90} for the mean concentrations, standard deviations, and the number of samples collected for each VOC in the headspace gas of waste containers in the waste stream (if applicable)
- ! The potential flammability of TRU waste headspace gases
- ! Mean concentrations, UCL_{90} for the mean concentrations, standard deviations, and number of samples collected for VOCs, SVOCs, and metals in the waste stream
- ! Whether the waste stream exhibits a toxicity characteristic (TC) under 40 CFR Part 261, Subpart C
- ! Whether the waste stream can be classified as hazardous or nonhazardous at the 90-percent confidence level
- ! Whether a sufficient number of waste containers have been visually examined (as a QC check on radiography) undergone a QC check on radiography to determine with a reasonable level of certainty that the UCL_{90} for the misclassification rate is less than 14 percent (if applicable)

e. 8. Attachment B3-12b(1)

RTR Radiography and/or VE summary to document prohibited items are not present and to confirm AK.

e. 9. Attachment B3, Table B3-11

**TABLE B3-11
TESTING BATCH DATA REPORT CONTENTS**

Required Information	Radiography	Visual Examination as QC Check on Radiography	Visual Verification of Acceptable Knowledge	Comment
Batch Data Report Date	X	X	X	
Batch number	X	X	X	
Waste container number	X	X	X	
Waste stream name and/or number	O	O	O	
Waste Matrix Code	X	X	X	Summary Category Group included in waste matrix code
Implementing procedure (specific version used)	X	X	X	If procedure cited contains more than one method, the method used must also be cited. Can use revision number, date, or other means to track specific version used.
Container type	O	O	O	Drums, Standard Waste Box, Ten Drum Overpack, etc.

Required Information	Radiography	Visual Examination as QC Check on Radiography	Visual Verification of Acceptable Knowledge	Comment
Videotape or video/audio data reference	X	X		Reference to Videotape(s), or video/audio data applicable to each container. For visual examination (for characterization) of newly generated waste, videotape, or video/audio data not required if two trained operators review the contents of the waste container to ensure correct reporting.
Imaging check	O	O (for DR/CT independent review)		
Camera check		O		
Audio check	O	O		
QC check of scales		O	O	Available documented evidence calibrated scale(s) were used. Only applicable if items are weighed during the visual examination.
QC documentation	X	X	X	
Description of liners and layers of confinement (if possible)	X	X	X	
Indication of vented rigid liners	O	X	X	Only required for containers with rigid liners. If RTR is used to verify, then include in Testing Batch Data Report.

Required Information	Radiography	Visual Examination as QC Check on Radiography	Visual Verification of Acceptable Knowledge	Comment
Description of container contents	X	X	X	Provide enough detail for verification of estimated weights for the 12 waste matrix parameters.
Verification that the physical form matches the waste stream description and Waste Matrix Code.	X	X	X	Summary Category Group included in waste matrix code
Indication of sealed containers > 4L	X	X	X	
Amount of free liquids	X	X	X	
Estimated weights for the 12 waste matrix parameters	X	X	X	Table B3-1 lists waste matrix parameters.
Container gross weight	X	X	X	
Container empty weight	O	O	O	Established, documented empty container weights can be used.
Comments	X	X	X	
Reference to or copy of associated NCRs, if any	X	X	X	Copies of associated NCRs must be available.
Visual examination expert decisions		X		Only applicable if visual examination expert is consulted during visual examination.
Verify absence of prohibited items	X	X	X	

Required Information	Radiography	Visual Examination as QC Check on Radiography	Visual Verification of Acceptable Knowledge	Comment
Operator signature and date of test	X	X	X	2 signatures required for Visual Verification of Acceptable Knowledge
Signature of visual examination expert and date		X		When visual examination expert is consulted.
Data review checklists	X	X	X	

LEGEND:

X - Required in batch data report.

O - Information must be documented and traceable; inclusion in batch data report is optional.

f. 1. Attachment B4-1

Sampling and analysis shall be performed to confirm acceptable knowledge and to update and modify initial AK assessments. Sampling and analysis includes radiography, **and/or** visual examination, headspace gas, and homogeneous waste sampling and analysis. TRU mixed waste streams shall undergo applicable provisions of the acceptable knowledge process prior to management, storage, or disposal by the Permittees at WIPP.

f. 2. Attachment B4-3d

Waste characterization (i.e., radiography **and/or** visual examination, headspace-gas sampling and analysis, and homogeneous waste sampling and analysis) will be used to confirm acceptable knowledge information.

All retrievably stored waste shall be characterized using radiography **and/or** visual examination to confirm the Waste Matrix Code and waste stream and certify compliance with the WAP (Permit Attachment B).

g. 1. Attachment B6

B6-1	General Waste Analysis Plan (WAP) and Project Level Data Review Checklist	B6-8
B6-2	Solids and Soil/Gravel Sampling and Data Generation Level Review Checklist	B6-26
B6-3	Solids and Soil/Gravel Analysis and Data Generation Level Review Checklist	B6-51
B6-4	Acceptable Knowledge (AK) Checklist	B6-67
B6-5	Headspace Gas Sampling and Data Generation Level Review Checklist	B6-88
B6-6	Headspace Gas Analysis and Data Generation Level Review Checklist.. ..	B6-112

B6-7	Radiography and Data Generation Level Review Checklist . . .	B6-127
B6-8	Visual Examination (QC Check on Radiography RTR) and Data Generation Level Review Checklist	B6-144
B6-9	Visual Examination Technique and Data Generation Level Review Checklist	B6-161
B6-10	Quality Assurance Areas Checklist	B6-176

g. 2. Table B6-1

7	<p>Are procedures in place to ensure that the following characterization activities shall occur for retrievably stored wastes:</p> <p>Acceptable knowledge for all wastes, with confirmatory:</p> <p>A. Visual examination or radiography for all waste containers (Section B-3d(2), B4-3d)</p> <p>B. Confirmatory visual examination Verification of radiography of on a statistically determined number of waste containers as specified in Attachment B2 (when radiography is performed) (Section B-3d(2))</p> <p>C. Headspace gas analysis for all waste containers or randomly selected containers from waste streams that meet the conditions for reduced headspace gas sampling listed in Section B-3a(1) (Section B-3d(2))</p> <p>D. Total VOCs, SVOCs, and metals analyses for a statistically selected number of homogeneous solids and soil/gravel waste containers as specified in Attachment B2 (containers opened for sampling may be used to fulfill the visual examination requirements) (Section B-3d(2))</p>
9	<p>Are procedures in place to ensure that the following data quality objectives are met:</p> <p>A. Use headspace gas sampling and analysis to identify and quantify VOCs to ensure compliance with the environmental performance standards of 20.4.1.500 NMAC and to confirm hazardous waste identification by acceptable knowledge</p> <p>B. Perform totals analyses of homogeneous solids and soil/gravel wastes to compare UCL_{90} values for the mean measured contaminant concentrations in a waste stream with specified toxicity characteristic levels in 20.4.1.200 NMAC to determine if the waste is hazardous and to confirm hazardous waste characterization by acceptable knowledge</p> <p>C. Perform totals analyses of homogeneous solids and soil/gravel wastes to report the average concentration of</p>

	<p>hazardous constituents in a waste stream, as specified in 20.4.1.200 NMAC, with a 90 percent confidence interval, with all averages greater than the PRQL considered a detection and subsequent assignment, as applicable, of a hazardous waste code, and to confirm hazardous waste characterization by acceptable knowledge</p> <p>D. Use radiography or visual examination to verify physical waste form, identify prohibited items, verify determination of sampling and analytical requirements, and to confirm waste stream delineation by acceptable knowledge</p> <p>E. Use visual examination QC of radiography as a process check of radiography (Section B-4a(1))</p>
14	<p>At the project level, are procedures in place to ensure that 100 percent of all Batch Data Reports shall have a Site Project QA Officer signature release with an associated review checklist before the associated waste is managed, stored, or disposed of at the WIPP? This release shall ensure the following, as applicable:</p> <p>A. Sampling batch field QC checks were properly performed and meet established QAOs and data usability criteria</p> <p>B. Testing batch QC checks were properly performed. Radiography data are complete and acceptable based on evidence of videotape or equivalent record review of one waste container per testing batch, at a minimum</p> <p>C. Analytical batch and on-line QC checks were properly performed and meet established QAOs and data usability criteria</p>
45	<p>Do procedures ensure that the Waste Matrix Code and waste material parameter weights are verified through a comparison of radiography and visual examination QC of radiography results? (Section B1-3b(3))</p>
48	<p>As a QC check on radiography, do procedures or other documentation require that the site open and visually examine either perform VE or a independent review of a DR/CT radiography scan on a statistical portion of the certified waste containers? (Section B-3c, B1-3b(3), B2-1)</p>
49	<p>Do site procedures ensure that the site use the data obtained from the visual examination QC of radiography to determine the percentage of miscertified waste containers for each Summary Category Group as required in Section B2-1? (Section B2-1)</p>

50	Do site procedures require that the site initially use a miscertification rate of 11% to calculate the number of waste containers that must be visually examined undergo a QC of radiography until a site-specific miscertification rate has been established? (Section B2-1)
51	Do site procedures require that the site-specific miscertification rate be applied initially to each Summary Category Group? Is a Summary Category Group-specific miscertification rate determined after 6 months or 50% of the Summary Category Group has undergone radiographic characterization? Is the entire Summary Category Group subject to the reevaluated Summary Category Group-specific miscertification rate? (Section B2-1)
52	Do site procedures require that the site-specific miscertification rate be reassessed annually by calculating a drum-weighted average of all historic Summary Category Group-specific miscertification rates? Do procedures ensure that sites use a miscertification rate of 1% for any site-specific or Summary Category Group-specific miscertification rate calculated to be less than 1%? (Section B2-1)
53	Do procedures ensure that the annual number of waste containers per Summary Category Group undergoing characterization meet the requirements of Table B2-1? (Section B2-1)
53a	Do site procedures ensure that, at a minimum, 2 containers per batch or 2 containers per day undergo an independent examination of the radiographic scan data for those sites employing that technique as a QC of radiography. (Section B1-3b(2))
55	Do procedures ensure that the results of the visual examination QC of radiography are forwarded to the radiography facility? (Section B1-3b(3))

g. 3. Table B6-2

4	Are procedures in place to ensure that the generator/storage site uses radiography, and/or visual examination, headspace gas sampling and analysis and, as applicable, homogeneous waste sampling and analysis, to confirm the absence of the prohibited waste listed above? (Section B-3, B-3c)
12	Are procedures in place to ensure that all raw data are collected and managed at the data generation level in accordance with the following criteria: <ul style="list-style-type: none"> A. All raw data shall be signed and dated in reproducible ink by the individual collecting the data, or signed and dated using electronic signatures B. All data shall be recorded clearly, legibly, and accurately in field and laboratory records and include all applicable sample identification numbers (for sampling and analytical labs)

	<p>C. All changes to original data shall be lined out, initialed, and dated by the individual making the change. Original data may not be obliterated or otherwise be made unreadable. Data changes shall only be made by the individual who originally collected the data or an individual authorized to change the data</p> <p>D. All data shall be transferred and reduced from field and laboratory records completely and accurately</p> <p>E. All field and laboratory records shall be maintained as specified in Table B-7 of Attachment B</p> <p>F. Data shall be organized into standard reporting formats for each method of analysis</p> <p>G. All electronic and video data or equivalent electronic records are stored to ensure that waste container, sample, and QC data are readily retrievable</p> <p>(Section B3-10a)</p>
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g. 4. Table B6-3

12	<p>Are procedures in place to ensure that the following characterization activities shall occur for retrievably stored wastes:</p> <p>Acceptable knowledge for all wastes, with confirmatory:</p> <p>A. Visual examination or radiography for all waste containers (Section B-3d(2), B4-3d)</p> <p>B. Confirmatory visual examination QC of radiography of a statistically determined number of waste containers as specified in Attachment B2 (when radiography is performed) (Section B-3d(2))</p> <p>C. Headspace gas analysis for all waste containers or randomly selected containers from waste streams that meet the conditions for reduced headspace gas sampling listed in Section B-3a(1) (Section B-3d(2))</p> <p>D. Total VOCs, SVOCs, and metals analyses for a statistically selected number of homogeneous solids and soil/gravel waste containers as specified in Attachment B2 (containers opened for sampling may be used to fulfill the visual examination requirements) (Section B-3d(2))</p> <p>E. Evaluation of any TICs found in headspace gas and totals analyses (Section B-3d)</p>
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g. 5. Table B6-4

13	<p>Are procedures in place to ensure that the following characterization activities shall occur for retrievably stored wastes:</p> <p>Acceptable knowledge for all wastes, with confirmatory:</p> <ul style="list-style-type: none"> A. Visual examination or radiography for all waste containers (Section B-3d(2), B4-3d) B. Confirmatory visual examination of a statistically determined number of waste containers TRU mixed waste containers are randomly selected to undergo a QC check of the initial radiography to verify radiography results as specified in Attachment B2 (when radiography is performed) (Section B-3d(2)) C. Headspace gas analysis for all waste containers or randomly selected containers from waste streams that meet the conditions for reduced headspace gas sampling listed in Section B-3a(1) (Section B-3d(2)) D. Total VOCs, SVOCs, and metals analyses for a statistically selected number of homogeneous solids and soil/gravel waste containers as specified in Attachment B2 (containers opened for sampling may be used to fulfill the visual examination requirements) (Section B-3d(2)) E. Evaluation of any TICs found in headspace gas and totals analyses (Section B-3d)
15	<p>Are procedures in place to ensure that the following data quality objectives are met:</p> <ul style="list-style-type: none"> A. Use headspace gas sampling and analysis to identify and quantify VOCs to ensure compliance with the environmental performance standards of 20.4.1.500 NMAC and to confirm hazardous waste identification by acceptable knowledge B. Perform totals analyses of homogeneous solids and soil/gravel wastes to compare UCL_{90} values for the mean measured contaminant concentrations in a waste stream with specified toxicity characteristic levels in 20.4.1.200 NMAC to determine if the waste is hazardous, and to confirm hazardous waste characterization by acceptable knowledge C. Perform totals analyses of homogeneous solids and soil/gravel wastes to report the average concentration of hazardous constituents in a waste stream, as specified in 20.4.1.200 NMAC, with a 90 percent confidence interval, with all averages greater than the PRQL considered a detection

	<p>and subsequent assignment, as applicable, of a hazardous waste code, and to confirm hazardous waste characterization by acceptable knowledge</p> <p>D. Use radiography or visual examination to verify physical waste form, identify prohibited items, verify determination of sampling and analytical requirements, and to confirm waste stream delineation by acceptable knowledge</p> <p>E. Use visual examination or an independent examination of a radiography scan as a process check of radiography (Section B-4a(1))</p>
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g. 6. Table B6-6

4	<p>Are procedures in place to ensure that the generator/storage site uses radiography, and/or visual examination, headspace gas sampling and analysis and, as applicable, homogeneous waste sampling and analysis, to confirm the absence of the prohibited waste listed above? (Section B-3, B-3c)</p>
12	<p>Are procedures in place to ensure that the following characterization activities shall occur for retrievably stored wastes:</p> <p>Acceptable knowledge for all wastes, with confirmatory:</p> <p>A. Visual examination or radiography for all waste containers (Section B-3d(2), B4-3d)</p> <p>B. Confirmatory visual examination QC of radiography of a statistically determined number of waste containers as specified in Attachment B2 (when radiography is performed) (Section B-3d(2))</p> <p>C. Headspace gas analysis for all waste containers or randomly selected containers from waste streams that meet the conditions for reduced headspace gas sampling listed in Section B-3a(1) (Section B-3d(2))</p> <p>D. Total VOCs, SVOCs, and metals analyses for a statistically selected number of homogeneous solids and soil/gravel waste containers as specified in Attachment B2 (containers opened for sampling may be used to fulfill the visual examination requirements) (Section B-3d(2))</p> <p>E. Evaluation of any TICs found in headspace gas and totals analyses (Section B-3d)</p>

g. 7. Table B6-7

	<p>Are procedures in place to ensure that the generator/storage site uses</p>
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6	radiography, and/or visual examination, headspace gas sampling and analysis and, as applicable, homogeneous waste sampling and analysis, to confirm the absence of the prohibited waste listed above? (Section B-3, B-3c)
14	<p>Are procedures in place to ensure that 100 percent of Batch Data Reports are subject to independent technical review by an individual qualified to review the data? The reviewer shall release the data through signature with an associated review checklist prior to characterization of the associated waste and shipment to the WIPP. The review shall ensure the following, as applicable:</p> <ul style="list-style-type: none"> A. Data were generated according to the methods used (procedure and revision) and reported in the proper units B. Calculations have been verified by a valid calculation program, a spot check of verified calculation programs, and/or a 100 percent check of all hand calculations C. The data have been reviewed for transcription errors D. The testing, sampling, and analytical QA documentation for Batch Data Reports is complete and includes (as applicable) raw data, calculation records, chain-of-custody forms, calibration records, QC sample results, and originals or copies of gas sample canister tags E. All QC sample results are within established control limits and, if not, the data have been appropriately qualified F. Reporting flags were assigned correctly (Table B3-14) G. Sample holding times and preservation requirements were met or exceptions documented H. Radiography tapes or equivalent electronic records are reviewed (independent observation) on a waste container basis at a minimum of once per testing batch or once per day of operation, whichever is less frequent. The radiography tape or equivalent electronic records will be reviewed against the data on the radiography form to ensure that data are complete and correct. For DR/CT, one of the 2 independent reviews of the DR/CT scan per batch or per day fulfills this requirement. I. Field sampling records are complete (B3-10a(1))
28	<p>Are processes/procedures in place to meet the following quality assurance objectives:</p> <ul style="list-style-type: none"> A. <u>Precision</u> <ol style="list-style-type: none"> 1. Did the Site Project QA Officer calculate and report the relative percent difference (RPD) between the estimated

	<p>waste material parameter (WMP) weights as determined by radiography and these same parameters as determined by visual examination (VE) a QC of radiography?</p> <p>2. Is the precision of radiography verified prior to use by tuning precisely enough to demonstrate compliance with QAOs through viewing an image test pattern?</p> <p>B. Accuracy</p> <p>1. Was the programmatic accuracy at which the of Waste Matrix Code confirmations and WMP weights were determined documented through VE QC of radiography of a randomly selected statistical portion of waste containers, and was the accuracy documented.</p> <p>2. Was the percentage of waste containers that require assignments to a different Waste Matrix Code or were found to contain prohibited items after VE QC of radiography as a measure of radiography accuracy calculated and reported by the Site Project QA Officer?</p> <p>C. Completeness</p> <p>1. Was an audio/videotape (or equivalent media) of the radiography examination and a radiography data form validated according to the requirements in Section B3-10?</p> <p>2. Was an audio/videotape (or equivalent media) of the radiography examination and a validated radiography data form obtained for 100% of the retrievably stored waste containers?</p> <p>D. Comparability</p> <p>Is comparability ensured through the use of standardized radiography procedures and operator training and qualifications? (Section B1-3b)</p> <p>(Section B3-4)</p>
31	Do procedures ensure that containers with lead liners are examined by visual examination rather than or by a radiography system capable of viewing the drum contents through the lead liner? (Section B1-3a)
32	Are there procedures to ensure that the data obtained from an audio/videotaped or equivalent record scan are provided by trained radiography operators? (Section B1-3b)
35	<p>Did the X-ray producing device have controls or an equivalent process which allow the operator to vary voltage, thereby controlling image quality? Was it possible to vary the voltage, typically between 150 and 400 kV, or control the scan quality to provide an optimum degree of penetration through the waste?</p> <p>Was high-density material examined with the X-ray device set on the</p>

	<p>maximum voltage appropriately for maximum penetration?</p> <p>Was low-density material examined at lower voltage appropriate settings to improve contrast and image definition?</p> <p>(Section B1-3a)</p>
58	<p>For sites that do not use digital radiography and computed tomography:</p> <p>Do procedures ensure that independent replicate scans and replicate observations of the video or equivalent records output of the radiography process are performed under uniform conditions and procedures? Are independent replicate scans performed on one waste container per day or once per testing batch of up to 20 samples, whichever is less frequent?</p> <p>Are independent observations of one scan (not the replicate scan) performed once per day or once per testing batch, whichever is less frequent, by a qualified radiography operator other than the individual who performed the first examination? (Section B1-3b(2))</p> <p>For sites that use digital radiography and computed tomography:</p> <p>Do procedures ensure that independent interpretations of the digital record of the radiography process are performed under uniform conditions and procedures.</p> <p>Are independent interpretations of the digital record of the radiography process performed on 2 randomly selected waste containers per day or 2 per batch containers whichever is less frequent?</p>
59	<p>Do procedures ensure that oversight functions, including periodic audio/videotape (or equivalent media) reviews of accepted waste containers, are performed by qualified radiography personnel (other than the operator who dispositioned the waste container)? (Section B1-3b(2))</p>
59A	<p>Are procedures in place to ensure that a site specific Performance Evaluation Program is in place to evaluate the QC of radiography when DR/CT is used in lieu of VE?</p>
60	<p>Do procedures ensure that the radiography operators have access to the visual examination QC of radiography results? (Section B1-3b(2))</p>
62	<p>Do procedures ensure that the generator data meet all applicable requirements for data collection and management as specified in B3-10a? (B3-10a)</p> <p>With the exception of identifying items or conditions that could pose a hazard, the radiography results are not made available to visual examination personnel involved in the QC of radiography until after the visual examination QC of radiography is completed. (Section B1-</p>

	3b(3))
64	Do procedures ensure that radiography tapes or equivalent record have been reviewed (independent observation) on a waste container basis, at a minimum of once per testing batch or once per day of operation, whichever is less frequent, against the data reported on the radiography form to ensure that data are correct and complete? (Section B3-10a(1))

g. 8. Table B6-8

6	Are procedures in place to ensure that the generator/storage site uses radiography and/or , visual examination, headspace gas sampling and analysis and, as applicable, homogeneous waste sampling and analysis, to confirm the absence of the prohibited waste listed above? (Section B-3, B-3c)
9	<p>Are procedures in place to ensure that the following characterization activities shall occur for retrievably stored wastes:</p> <p>Acceptable knowledge for all wastes, with confirmatory:</p> <ul style="list-style-type: none"> A. Visual examination or radiography for all waste containers (Section B-3d(2), B4-3d) B. Confirmatory visual examination QC of radiography of a statistically determined number of waste containers as specified in Attachment B2 (when radiography is performed) (Section B-3d(2)) C. Headspace gas analysis for all waste containers or randomly selected containers from waste streams that meet the conditions for reduced headspace gas sampling listed in Section B-3a(1) (Section B-3d(2)) D. Total VOCs, SVOCs, and metals analyses for a statistically selected number of homogeneous solids and soil/gravel waste containers as specified in Attachment B2 (containers opened for sampling may be used to fulfill the visual examination requirements) (Section B-3d(2)) E. Evaluation of any TICs found in headspace gas and totals analyses (Section B-3d)
11	<p>Are procedures in place to ensure that the following data quality objectives are met:</p> <ul style="list-style-type: none"> A. Use radiography or visual examination to verify physical waste form, identify prohibited items, verify determination of sampling and analytical requirements, and to confirm waste stream delineation by acceptable knowledge B. Use visual examination or a second radiography examination

	<p>of the container as described in B1-3b(3)(ii) as a process check of radiography (Section B-4a(1))</p>
17	<p>Are procedures in place to ensure that 100 percent of Batch Data Reports are subject to independent technical review by an individual qualified to review the data? The reviewer shall release the data through signature with an associated review checklist prior to characterization of the associated waste and shipment to the WIPP. The review shall ensure the following, as applicable:</p> <ul style="list-style-type: none"> A. Data were generated according to the methods used (procedure and revision) and reported in the proper units B. Calculations have been verified by a valid calculation program, a spot check of verified calculation programs, and/or a 100 percent check of all hand calculations C. The data have been reviewed for transcription errors D. The testing, sampling, and analytical QA documentation for Batch Data Reports is complete and includes (as applicable) raw data, calculation records, chain-of-custody forms, calibration records, QC sample results, and originals or copies of gas sample canister tags E. All QC sample results are within established control limits and, if not, the data have been appropriately qualified F. Reporting flags were assigned correctly (Table B3-14) G. Sample holding times and preservation requirements were met or exceptions documented H. Radiography tapes or equivalent records are reviewed (independent observation) on a waste container basis at a minimum of once per testing batch or once per day of operation, whichever is less frequent. The radiography tape or equivalent records will be reviewed against the data on the radiography form to ensure that data are complete and correct I. Field sampling records are complete (B3-10a(1))
35	<p>Do procedures ensure that containers with lead liners are examined by visual examination rather than by radiography or are examined by a system that has the capability to view waste through lead lined drums? (Section B1-3a)</p>
40	<p>As a QC check on radiography, do procedures or other documentation require that the site open and visually examine perform either visual examination or perform a second interpretation of the digital record a statistical portion of the certified waste containers? (Section B-3c, B1-</p>

	3b(3), B2-1)
41	Do site procedures ensure that the site use the data from visual examination QC of radiography to check the Waste Matrix Code, absence of prohibited items, and waste material parameter weight estimates, as determined by radiography? (Section B2-1)

g. 9. Table B6-9

5	Are procedures in place to ensure that the generator/storage site uses radiography, and/or visual examination, headspace gas sampling and analysis and, as applicable, homogeneous waste sampling and analysis, to confirm the absence of the prohibited waste listed above? (Section B-3, B-3c)
8	<p>Are procedures in place to ensure that the following characterization activities shall occur for retrievably stored wastes:</p> <p>Acceptable knowledge for all wastes, with confirmatory:</p> <ul style="list-style-type: none"> A. Visual examination or radiography for all waste containers (Section B-3d(2), B4-3d) B. Confirmatory visual examination QC of radiography of a statistically determined number of waste containers as specified in Attachment B2 (when radiography is performed) (Section B-3d(2)) C. Headspace gas analysis for all waste containers or randomly selected containers from waste streams that meet the conditions for reduced headspace gas sampling listed in Section B-3a(1) (Section B-3d(2)) D. Total VOCs, SVOCs, and metals analyses for a statistically selected number of homogeneous solids and soil/gravel waste containers as specified in Attachment B2 (containers opened for sampling may be used to fulfill the visual examination requirements) (Section B-3d(2)) E. Evaluation of any TICs found in headspace gas and totals analyses (Section B-3d)
17	<p>Are procedures in place to ensure that 100 percent of Batch Data Reports are subject to independent technical review by an individual qualified to review the data? The reviewer shall release the data through signature with an associated review checklist prior to characterization of the associated waste and shipment to the WIPP. The review shall ensure the following, as applicable:</p> <ul style="list-style-type: none"> A. Data were generated according to the methods used (procedure and revision) and reported in the proper units B. Calculations have been verified by a valid calculation

	<p>program, a spot check of verified calculation programs, and/or a 100 percent check of all hand calculations</p> <p>C. The data have been reviewed for transcription errors</p> <p>D. The testing, sampling, and analytical QA documentation for Batch Data Reports is complete and includes (as applicable) raw data, calculation records, chain-of-custody forms, calibration records, QC sample results, and originals or copies of gas sample canister tags</p> <p>E. All QC sample results are within established control limits and, if not, the data have been appropriately qualified</p> <p>F. Reporting flags were assigned correctly (Table B3-14)</p> <p>G. Sample holding times and preservation requirements were met or exceptions documented</p> <p>H. Radiography tapes or equivalent data records are reviewed (independent observation) on a waste container basis at a minimum of once per testing batch or once per day of operation, whichever is less frequent. The radiography tape or equivalent data records will be reviewed against the data on the radiography form to ensure that data are complete and correct. For DR/CT, one of the 2 independent reviews of the DR/CT scan per batch or per day fulfills this requirement.</p> <p>I. Field sampling records are complete (B3-10a(1))</p>
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g. 10. Table B6-10

9	<p>Are procedures in place to ensure that the generator/storage site maintains records that are designated as Non-Permanent Records for ten years from the date of record generation, and then dispositions them per the approved RIDS?</p> <p>Non-Permanent Records include:</p> <p>A. Nonconformance documentation</p> <p>B. Variance documentation</p> <p>C. Assessment documentation</p> <p>D. Gas canister tags</p> <p>E. Methods performance documentation</p> <p>F. PDP documentation</p> <p>G. Sampling equipment certifications</p> <p>H. Calculations and related software documentation</p> <p>I. Training/qualification documentation</p> <p>J. QAPjP documentation (all revisions)</p> <p>K. Calibration documentation</p>
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	<p>L. Analytical raw data</p> <p>M. Procurement documentation</p> <p>N. QA procedures (all revisions)</p> <p>O. Technical implementing procedures (all revisions)</p> <p>P. Audio/video recording or equivalent data records (radiography, visual, etc.)</p> <p>(Section Table B-7, B-4a(7))</p>
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Attachment B

Computed Tomography Technical Specifications and Information

Computed Tomography (CT)

The word tomography is derived from the Greek **tomos**, meaning slice or section, and **graphein**, meaning to write or record.

CT creates cross section images by projecting a thin-beam x-ray through on place of an object from many different angles. As the x-rays pass through the object, some radiation is absorbed, some is scattered, and some is transmitted. In some scanners a cone-beam covers an area detector so that many slices, or a volume, can be scanned at once.

The radiation transmitted through the object at each angle is measured and referred to as **attenuation data**. It is a measure of the reduction in x-ray intensity that results from absorption and scattering by the object.

In CT scanning, the attenuation data is summed over the many different angles from which it was collected using a computer in a method called reconstruction. Reconstruction essentially “builds” the CT image from the data collected and represents a cross section of the object.

CT scanners typically consist of 4 hardware subsystems: a radiation **source**, a radiation **detector** system, a mechanical **manipulator**, and a computer with display. The radiation detector system is composed of detection elements, such as scintillating crystals and photodiodes. A data acquisition system (DAS) measures radiation data transmitted through the object and digitizes it into a format that can be handled by the scanner’s computer system.

A mechanical manipulator is needed to precisely move the object relative to the x-ray source and detector system. Finally, a CT system requires a computer to control the scan motion and the timing of data acquisition. The computer then also reconstructs the image from raw scan data.

CT Scanning Generations

As computed tomography technology developed, researchers created improved methods of collecting the x-ray projections through an object. These methods were called **generations**, and use different **motions** to collect the projections.

First Generation Method: Single Detector Translate-Rotate

This geometry transverses a single pencil beam of x-ray linearly across an object. Once a traverse is completed, the object is rotated a small amount (typically 1 degree) and the transverse is repeated up to at least 180E of rotation.

Second Generation Method: Multidetector Translate-Rotate

This is an extension of the first generation. By increasing the number of detectors to encompass a small fan of x-rays, each detector sees its own parallel set of rays because of the transverse motion.

Third Generation Method: Rotate-Rotate

This generation of DR/CT is what is proposed within this modification.

Both the x-ray tube and the multidetector array rotate around the object. Each detector thus covers a different annulus, rather than the whole object. In industrial applications, the object rotates rather than the x-ray source and detector(s). With no transverse motion, scans can be done in a few seconds. However, the beam must span the entire width of the object, increasing detection costs. Since data is not in parallel beams, complex reconstruction algorithms are used.

Fourth Generation Method: Rotate-Stationary

Used almost exclusively for medical application, this method relies on a non-rotating complete ring of detectors with only the x-ray tube rotating. There are few artifacts than in third generation because very detector covers every point in the object. Many fourth generation systems can scan in 1 second.

Technical Summary

Problem

The Department of Energy (DOE) has in excess of 600,000 nuclear waste drums currently stored at more than 30 sites within the United States that need to be characterized over the next several years. The contents of these drums must be characterized and designated as high-level waste (HLW), low-level waste (LLW), or transuranic waste (TRU), prior to assigning these drums to a permanent storage location. Many of the drums contain dense materials, such as sludge or cement, making them difficult to characterize by existing non-invasive technologies.

Non-destructive Examination (NDE) technology is utilized to generate x-ray images of drum's contents. NDE includes conventional radiography or Digital Radiography (DR) to provide an entire drum projection, and Computed tomography (CT) to provide a slice plan and volume x-ray imaging of drum contents. With high-energy and/or high sensitivity CT NDE can identify both lightweight matrices, such as clothing, and dense matrices, like sludge, steel pipe overpacks, and lead-lined drums.

Features

Three-dimensional NDE CT volume-rendering, with cinematic rotation of drum cut-aways, including surface shaded displays, can provide reviewers with spatial orientation of both the matrix as well as radioactivity in a drum. This capability provides a safe, noninvasive method of verifying drum contents without the need for opening and repackaging a radioactive drum. CT volume-rendering of a drum, versus repackaging in a remote-handled glovebox, provides a cost savings of about 20:1.

Additional Information

Additional information on digital radiography and computed tomography may be found at the following Internet addresses:

www.wipp.carlsbad.nm.us/rcradox/rfc/com_menu.htm

<http://www.aeat.co.uk/ndt/tomohawk/tomohawk.html>

www.bio-imaging.com

www.llnl.gov/str/Logan.html

www.vjt.com

http://perso.wanadoo.fr/francois.pellerin/backup_web/Web_ang/principle.html

Attachment C

Figure B-3

Data Collection Design for Characterization of Retrievably Stored Waste

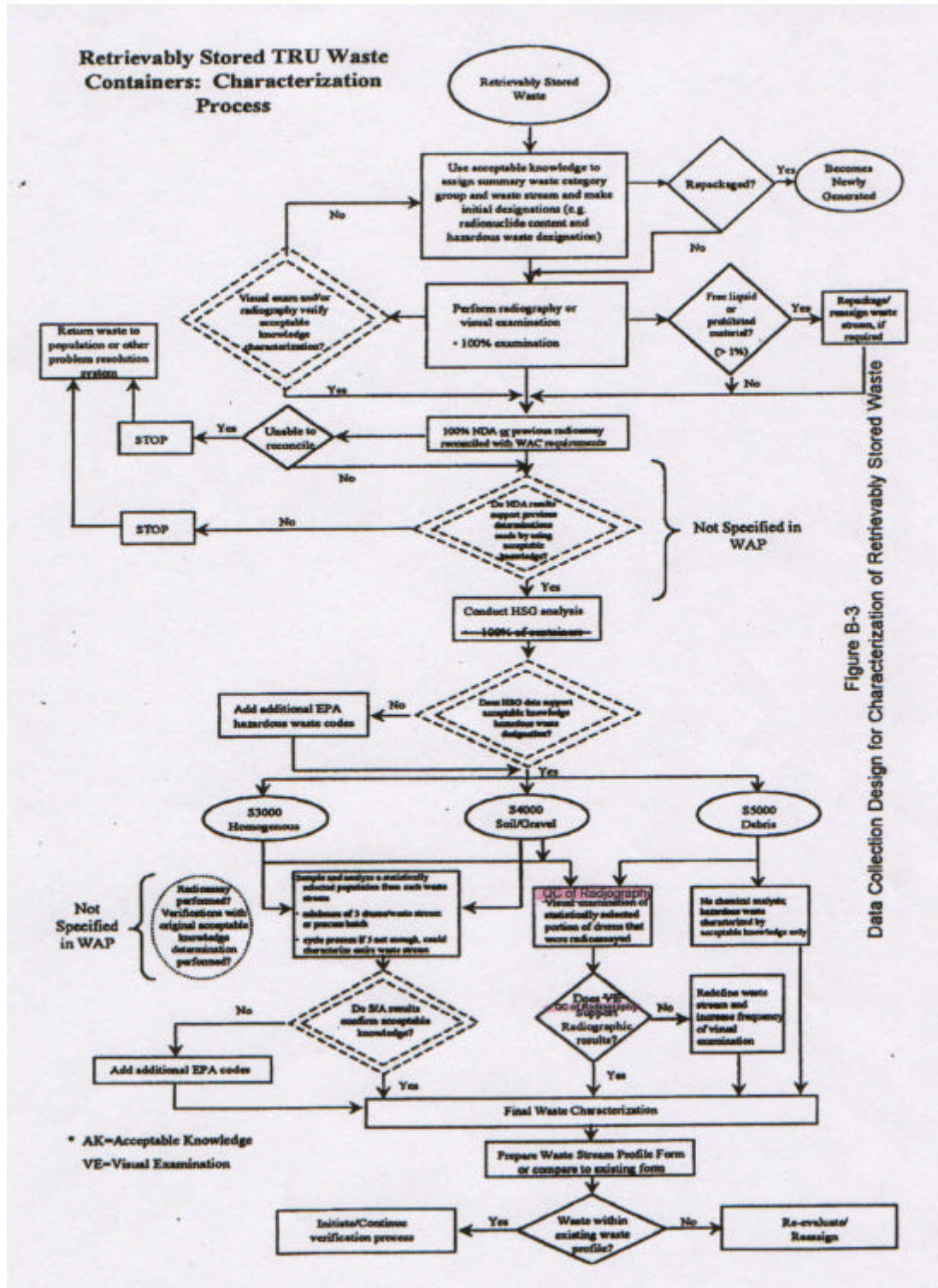


Figure B-3
Data Collection Design for Characterization of Retrievably Stored Waste

Figure B-3
Data Collection Design for Characterization of Retrievably Stored Waste

PERMIT ATTACHMENT B

Table B-7

Required Program Records Maintained in Generator/Storage Site Project Files

TABLE B-7
REQUIRED PROGRAM RECORDS MAINTAINED IN GENERATOR/STORAGE
SITE PROJECT FILES

<p><u>Lifetime Records</u></p> <ul style="list-style-type: none"> • Field sampling data forms • Field and laboratory chain-of-custody forms • Test facility and laboratory batch data reports • Waste Stream Characterization Package • Sampling Plans • Data reduction, validation, and reporting documentation • Acceptable knowledge documentation • Data reconciliation report • Waste Stream Profile Form and Characterization Information Summary
<p><u>Non-Permanent Records</u></p> <ul style="list-style-type: none"> • Nonconformance documentation • Variance documentation • Assessment documentation • Gas canister tags • Methods performance documentation • Performance Demonstration Program documentation • Sampling equipment certifications • Calculations and related software documentation • Training/qualification documentation • QAPjPs (generator/storage sites) documentation (all revisions) • Calibration documentation • Analytical raw data • Procurement documentation • QA procedures (all revisions) • Technical implementing procedures (all revisions) • Audio/video recording (radiography, visual, etc.) or digital records